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A COMPARISON BETWEEN EXPERIMENTAL DATA AND CLINICAL RESULTS IN MANIC- DEPRESSIVE INSANITY¹

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The purpose of this investigation was to determine to what extent the different phases of manic-depressive insanity might be demonstrated experimentally. Five different tests were used upon eleven different female subjects. The original intention was to test each subject while in the abnormal condition and then again later when she was normal. Circumstances prevented this being carried out except with two of the subjects. But three of the subjects were also tested a second time when there had been a change in their condition.

We have then sixteen different sets of data from eleven different patients.

The report will be subdivided as follows:

- I. Clinical Descriptions of the Eleven Patients.
- II. Results from the Five Tests.
- III. Relationship between the Clinical Descriptions and the Experimental Results.

I. CLINICAL DESCRIPTION OF THE MANIC-DEPRESSIVE PATIENTS

The eleven subjects were all patients in the clinical service of the Psychiatric Institute on Ward's Island, New York City. Since some of them were tested when in different pathological conditions, it is necessary to consider them under more than one head. Pr., for instance, was tested three times; and the results of the three tests will be referred to as

¹ In making this study I am greatly indebted to Dr. F. L. Wells, now at McLean Hospital, Waverly, Mass., and to Dr. August Hoch, Director of the Psychiatric Institute of the New York State Hospitals. It was under the former's direction that the tests were planned and commenced. The latter has supplied the clinical descriptions, without which little of value could have been obtained. I wish also to express here my appreciation of the help accorded me in the Hospital Ward by Dr. C. M. Campbell, now of the Bloomingdale Hospital, White Plains, N. Y.

Pr.I, Pr.II, and Pr.III. Pr.I and Pr.II are recorded under the heading of *normal* because the patient was practically normal at the time of the first test, and she was about to be discharged at the time of the second test. She had another attack of depression shortly afterwards; and after her re-admission to the hospital she was tested for the third time. This test is recorded under the heading of depression.

We have then the following groups:

Normal: Pr.I, Pr.II, Po.III.

Depression: 1. Retarded primarily: Hi.

2. Depressed, primarily: Pr.III, Ha., Bu.

Manic: Fr.I, Fr.II, Wa., Sh., Wi., Po.I, Po.II, Re.

Depression (suggesting dementia praecox): Go.

The following are the clinical descriptions of the patients:

Mrs. L. Hi. Age 43. Manic-depressive insanity.

First attack seven months after death of husband. Rather slow, sometimes particularly with initial retardation; uneasy with feeling of impending trouble. Has difficulty in mental application. Sometimes, however, though the expression does not change from that of worry, she says she feels all right.

April 14. Rather slow at first part of interviews, somewhat anxious at times.

Miss M. Pr. Age 55. Recurrent Depression (Manic-depressive insanity).

Has had seven previous attacks of depression, all since menopause. Attacks are characterized by inability to work or plan; by feeling of depression and dullness in head; by manifestations of emotional depression at times not very marked, at others more so. Occasionally she is even somewhat agitated.

Feb. 24. Practically no symptoms.

March 10. Practically no symptoms. Discharged from hospital on March 12.

May 19. Depressed. Records of both May 12 and June 7 speak of depression and inadequacy.

Mrs. T. Ha. Age 32. Recurrent depression.

When 22 had attack similar to the present one. Present attack characterized essentially by a feeling of loss of affection and a numb and dead feeling in the body. Chafes under this and is rather inclined to talk about it. But often exhibits natural behavior without essential change in the condition. Capable of a fair amount of occupation, and not at all slow in working. Condition quite stable.

Mrs. H. Bu. Age 47. Recurrent depression.

One attack when 30. Present attack has lasted with variations, and even short intermissions, for three years. At first she was dull, agitated, slow, later the attack was characterized by a feeling that she could take no interest, had not the same affection for her family, not the same strength for working, was not so ambitious. She complained of feeling as if the nerves were dead, of the head feeling as if the brain were dead, and the body as if there were "no insides." But the outside world seemed unchanged. The condition was quite stable for a considerable period during which the tests were made.

Mrs. E. Fr. Age 38. Allied to manic-depressive insanity (maniac attack).

An emotional personality. A rather prolonged quarrel with her husband ended in this attack in which it is difficult to see the transition from the emotional upset to the pathological condition. Has shown herself, while here, easily stirred up when talking about her troubles and then sometimes rather rambling and even given to making occasional sound associations. Has made frequent statements that the nurses and patients called her names and threatened her and occasional accusations that the nurses wanted to choke her. All this is said with angry and complaining tones. Toward doctors rather coquettish and a little elated, a state of mind never shown otherwise.

Feb. 10. No hallucinations, but essentially somewhat unstable emotionally.

April 28. Less quiet than on Feb. 10. More easily stirred up, getting quite angry and breaking glass.

Miss M. C. Wa. Age 68. Manic-depressive insanity (manic).

Has had attacks for thirty years, eight in all. Admitted to hospital March 23. In her manic state she shows talkativeness and flight of ideas. She often shows more anger than elation.

April 7. Condition as above.

Mrs. M. Sh. Age 43. Manic-depressive insanity (manic).

Has had five former attacks, first, when twenty-nine, second, when thirty-one, third, when thirty-six, fourth, when thirty-nine, fifth, when forty-one. All manic, some preceded by depression. Exhibits typical manic-depressive excitement of mild type with some overactivity. Elation and flight of ideas

are present. At the time of the test the condition was quite moderate though there was an evident tendency to drift a little in talking.

Miss R. Wi. Age 17. Allied to manic-depressive insanity (circular type).

When fifteen, she began to say that her sick sister wanted to kill her, became excited about it and was taken to a hospital, where she varied in mood, was mischievous and depressed. Said a colored woman was her mother, that she herself was a queen. Said she saw moving pictures. Was discharged as recovered after nine months at the hospital. Since then she has had spells in which she will not talk to anyone and others in which she will sing and shout. She was admitted here Jan. 18, 1911. A short time before admission she began to say that she was a millionaire's daughter. Dressed her hair all the time. Said she wanted to be a teacher. But on the whole was well-behaved. Then quarreled several times with her mother and ran away repeatedly. Here, she has been elated, mischievous, given to singing Bowery songs. Has romanced considerably about her sister running after her before she died, etc., and accused her mother of sexual misconduct, all of which is without foundation. Tells all this voluminously but without flight of ideas. After a few weeks here she became quieter, then languid and somewhat, though not markedly, depressed. Similar variations since then. But at no time typical flight of ideas.

April 21. A little overactive and talkative, but not flighty.

Miss M. Po. Age 43. Manic-depressive insanity (manic).

A rather unstable personality and has had repeated attacks, most of them like the present, but also some simple depressions. Talks rather slowly at times, but even then apt to be rather talkative, at other times talks more quickly. Quite often shows a peculiar effort in thinking and an appreciation of this difficulty, while there is an evident flight of ideas, a drifting—very much like one who is tired and drifts while at the same time he has a clear appreciation of his difficulty in keeping to the topic.

March 3. Talkative, drifting, flighty, manic.

April 14. Drifting and difficulty in thinking.

May 19. Well.

Miss A. Re. Age 42. Manic-depressive insanity (manic).

A case about whose history very little is known, except that she was in the habit of occupying herself with palmistry,

fortune telling, etc. Under observation was generally rather quiet, but when talked to elated, bright, and with typical flight of ideas and accusing remarks, yet withal some odd references to occult matters. Later the manic traits became much less marked; but she was essentially irritable and apt to commit assault when interviewed. For the most part she sat looking out of the window. Discharged to another hospital in this condition.

April 28. Manic traits were quite marked.

Miss Go.

A girl of twenty-three who had been considerably handicapped by physical infirmity (hunchback, etc.). Her schooling was often interrupted. She was rather retiring and bashful. She got interested in music, was told that she had considerable talent, and under the stimulus of this, practised a great deal. About two and a half years before admission she fell in love with a young man but was told that he was only fooling her. This, she says, was "like a shot." She began to get depressed, had queer sensations in her stomach, cramps, etc. Then she began to develop a fear of men, turned somewhat against the family and shunned people more and more.

Under observation she showed a certain depression. This, however, was not associated with a consistent reduction of activity, under which she chafed. Her conduct was rather the outcome of her sensitiveness and feeling of inferiority which she often expressed clearly and which also came out in feelings of reference and hallucinations. She did not associate with anyone. Her hallucinations were simple, people say she is not like the rest. Quite prominent were a hypochondriacal element and a certain irritability like that of a spoiled child. The former found expression in her exaggerated complaints of physical discomforts, weakness, fear that her heart will stop beating, demands that the mother be notified as she might die to-night, etc.

This is not a simple depression as in manic-depressive insanity, but a constitutional depression in which there are even certain elements of a dementia praecox reaction, though the diagnosis of dementia praecox is by no means warranted.

II. RESULTS FROM FIVE TESTS

The five tests used in this study were: The tapping-test, discrimination of weights, the number-checking-test, a distraction test, and the free association test. They were

uniformly given in the following order: Tapping, number-checking, distraction, number-checking, distraction, association, weights. A different order was tried on two male subjects, not included in this study, and it was made very apparent that the tapping test should come first and the weight test last. The tapping test afforded a very good opportunity to get acquainted with the subjects and to put them at ease. The results are also not so apt to be influenced by uneasiness. The weight test, on the other hand, tends to be troublesome. The patients have less patience with it and some rather seriously object to guess when they think two weights are equal. My second subject, not included in this study, absolutely refused to co-operate and became so wrought up that I could not put him through the remaining tests.

1. *The Tapping-Test*

The method here was the same as used by Wells¹ and described by Whipple² in his *Manual of Mental and Physical Tests*. The subject tapped with an ordinary "sending" telegraph key for thirty seconds, first with the right hand and then with the left hand, alternately. Five records were obtained from each hand. Approximately two and a half minutes elapsed between each series. As the tapping was recorded on a kymograph it was possible to obtain the number of taps in each five-second interval of the thirty second series. This number is the unit of measurement upon which are based the results below.

The results will be considered under three different headings. The effect of continued work will be discussed, (a) as it affects the tapping-rate in successive series of the same hand and (b) as it affects the tapping-rate within a single series. (c) The gross tapping-rate will be considered. It is plain then that the factors of practice and fatigue enter into consideration under the first two headings but not under the third heading.

a. *Relations between Successive Series.*—There are two different methods of estimating the effect of continued work in the tapping test. One is to compare the successive series of the same hand together. That is the method used here. When the opposite of fatigue is shown it is referred to as

¹F. L. Wells, *Studies in Retardation*, *Amer. Jour. Psychol.*, XX, 1909, 38-59. Also, *Normal Performance in the Tapping Test*, *Ibid.*, XIX, 1908, 437 ff; and, *Motor Retardation as a Manic-Depressive Symptom*, *Amer. Jour. Insanity*, LXVI, 1909, 1-52.

²G. M. Whipple, *Manual of Mental and Physical Tests*, pp. 105-107.

"interserial warming-up." Another method is to compare the successive series when right and left hands alternate. In this case any effect which is noted is referred to as "transference."

Wells has pointed out that the first two series (30 sec. tapping-periods) of the same hand are generally the poorest in normal cases and that there is a "well-marked tendency for the later series to be faster than the earlier." To this phenomenon he has applied the name of "interserial warming-up," "a warming-up from series to series, as distinct from a warming up process confined to a single series." This phenomenon is noted by him as being common to the right hand, but as to the left, he says, "it is by no means so evident that such a process exists."

TABLE I

SHOWING AVERAGE NUMBER OF TAPS PER 5 SECOND PERIOD FOR EACH OF five 30 SECOND SERIES. (WELLS)

Series	Right Hand						Left Hand					
	1	2	3	4	5	f. i.	1	2	3	4	5	f. i.
10 Normal.....	32.0	31.7	32.3	33.2	33.2	102	28.8	28.7	29.0	28.7	28.8	100
12 Depressed.....	28.1	27.4	27.9	28.7	29.0	101	27.1	26.5	26.8	26.9	27.0	99

TABLE II

SHOWING AVERAGE NUMBER OF TAPS PER 5 SECOND PERIOD FOR EACH 30 SECOND SERIES

Series		Right Hand						Left Hand					
		1	2	3	4	5	f. i.	1	2	3	4	5	f. i.
Normal.	Pr. I....	32.2	32.8	33.2	32.8	32.2	102	29.7	28.2	28.0	28.3	27.2	94
	Pr. II....	31.8	31.2	32.0	32.5	33.0	101	26.8	26.5	27.2	27.7	28.0	102
	Po. III....	26.0	23.2	26.5	25.5	25.7	97	25.2	25.5	23.0	24.2	25.2	97
Depressed.	Hi.....	34.5	31.0	31.8	29.0	27.5	86	28.8	28.2	28.0	28.0	25.8	95
	Pr. III....	31.2	28.0	30.8	30.8	29.0	95	26.3	25.2	24.7	26.5	24.8	96
	Ha.(a)....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Bu.....	25.7	28.0	28.2	26.2	26.0	105	23.0	22.0	27.2	23.5	22.3	103
Manic.	Fr. I(a)....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fr. II....	30.5	28.7	28.5	27.8	28.7	93	26.3	25.7	26.7	26.7	27.0	101
	Wa.....	26.8	27.0	27.2	27.8	27.8	102	23.5	23.7	25.0	25.2	25.5	106
	Sh.....	22.5	21.7	24.5	25.7	25.5	108	22.5	20.8	22.7	23.3	21.5	98
	Wi.....	26.0	26.8	28.5	29.3	29.5	110	24.8	24.5	25.7	24.7	24.3	100
	Po. I.....	26.8	31.5	31.7	32.8	32.2	120	23.5	27.8	27.2	28.2	31.8	122
	Po. II....	25.3	25.8	26.8	25.2	28.0	105	25.5	24.2	23.8	23.7	23.5	93
	Re.....	27.5	24.0	20.8	30.8	31.8	106	23.5	24.0	27.0	27.8	31.3	117
	Go.....	29.7	30.7	28.0	28.2	27.5	96	20.7	26.0	25.8	24.5	23.2	84

(a) Due to a different method of procedure, the records of Ha. and Fr. I. cannot be compared with those of the other subjects and have consequently been omitted.

A summary of his data with respect to this point is given in Table I. Here the average number of taps per five-second interval for each thirty second series is given for a group of ten normal subjects and a group of twelve depressed subjects. Between every two series with the one hand there intervened a similar series with the other hand together with two rest periods of approximately $2\frac{1}{2}$ minutes. In order to aid the eye in determining whether the tapping-rate increased or decreased as we proceed from the first to the last series I have computed an index as a sort of summary. This index (f. i.) corresponds to the fatigue index (f) of Wells, which is described below, in that it was obtained by averaging the second to fifth series and dividing by the first. Indices above 100 thus indicate an increase in tapping-rate, while indices below 100 correspondingly represent a decrease.

Wells' data from ten normal subjects give average indices of 102 for the right hand and 100 for the left hand and from twelve depressed subjects indices of 101 for the right hand and 99 for the left.

The data from my experiment corresponding to Wells' results are given in Table II. The results from my three normal records give average indices of 100.0 for the right hand and 97.7 for the left. The average indices of the three depressed records give similarly 95.3 and 98.0. These average results do not agree with Wells' averages, being too low, especially in the right hand. However, four of Wells' depressed subjects do not show a gain in tapping-rate in the right hand and five do not in the left. The indices of the four are respectively, 95, 92, 96, and 96. Our average results for the normal and depressed cases are then lower than his averages but not different from some of his typical cases. The seven records from manic cases give averages of 106.3 in the right hand and 105.3 in the left hand. Four of the seven have indices of 100 or over in both hands, and the remaining three have such indices in one hand.

Wells states that one of the three criteria of motor retardation as shown by the tapping-test is that of a relative gain over the normal in the efficiency of the work that comes later in the experiments. He has emphasized this point by calling attention to the "transference" effect from one hand to the other,—the second hand showing greater efficiency, whereas in normal subjects it is just the reverse. This effect seems to be comparable to the well-known clinical observation that these subjects do better in the afternoon than the morning and better on mornings after sleepless nights than after

normal nights. Franz and Hamilton³ have shown that five minutes of mechanical vibration on the spinal cord or moderate exercise will apparently increase efficiency in some motor and sensory tests. And Hoch⁴ has found that with retarded subjects the second and third exhaustion curves on the ergograph are higher than the first, whereas the normal condition is a higher second but a lower third curve. However, in one more pronounced case, he found no "warming-up" at all.

Gross⁵ found in his study with the writing-balance that retarded subjects showed much *less* energy in their movements than normal subjects at the start and that continued writing only caused a decrease in the size of the characters written and an increase in the length of the pauses between characters. It is evident then that investigators do not agree as to the effect of continued work upon the efficiency of that work in retarded cases.

Hoch attempts to explain the apparent phenomenon of "warming-up," which he obtained with the ergograph, by suggesting that there exist resistances especially toward the initiation of motor impulses, and that these resistances are overcome to some extent at least during continued exercise of the function. If this is the case we should expect that the later series in the tapping test would be better than the earlier. It is evident from our data that there is this interserial warming-up in the case of Bu. but not with Hi. or Pr. III. Wells' data on this point, given in Table I, show that his twelve depressed subjects have less of this warming-up effect than his normal subjects. If the twelve are considered separately we find that only three show actual increase from series to series in both hands, eight show increase in one hand but not in the other, and one shows no increase in either hand.

It is evident then that although "transference" from one hand to the other or from one performance of one hand to another in that same hand is frequently found in the performance of motor acts, yet that not all depressed subjects show it. Hoch's most pronounced case was the exception for

³ S. I. Franz and G. V. Hamilton, The Effects of Exercise upon the Retardation in Conditions of Depression, *Amer. Jour. Insanity*, LXII, 1905, 239-256.

⁴ A. Hoch, On Certain Studies with the Ergograph, *Jour. Nervous and Mental Diseases*, XXVIII, 1901, 620-628. Also, A Review of some Psychological and Physiological Experiments done in Connection with the Study of Mental Diseases, *Psychol. Bull.*, I, 1904, 241-257.

⁵ A. Gross, Untersuchungen ueber die Schrift Gesunder und Geisteskranken, *Psych. Arbeiten*, II, 450-567.

him, while here our most serious case is the only one that showed it. Only future work can make clear just what these facts mean.

It has already been pointed out that the manic cases show an increased rate in tapping in the succeeding series as compared with the first series. Their average indices are 106.3 and 105.3 for the two hands. If the records of Po. II and Fr. II are excluded, not being typical manic cases, we have average indices of 109.2 and 108.6, respectively, with only one record below 100,—the left hand of Sh. (98). (Po. II was according to clinical evidence probably much more in a state of mental retardation than of manic excitement at the time of the test. Fr. II is classified as only allied to manic-depressive insanity.)

Similar warming-up effects with manic subjects have been obtained by other investigators. Gross, employing the writing-balance, found that the rate and manner of writing surpasses the normal records as a rule. This is almost never the case, however, at the start. Here the records are generally about equal, occasionally slower. But the act of writing increases the speed of writing in quite abnormal manner. As the work continues the writing becomes larger, the pressure greater with marked variations, the pauses between the characters shorter, the speed of the motion greater, and the entire writing more careless. Lefmann⁶ reports with continued work an acceleration and increase in writing. His manic subjects, as well as most of his mixed cases, all showed this. The latter, however, showed increase in the duration of the pauses. On the whole these mixed cases seemed to exhibit retarded symptoms in initiating each new movement but manic symptoms during the movement. All these records with manic cases show "that there exists not so much a motor excitement as an increased motor excitability."

Three conclusions seem to be warranted by my data.

1st. Increased performance in the following-hand ("transference" when alternate hands are considered, "interserial warming-up" when the same hand is considered in successive tests) over the preceding hand is shown in some depressed subjects, but not in all.

2nd. Interserial warming-up is characteristic of manic subjects. (No data concerning "transference" are at hand.) Or, in other words, increasing excitement accompanies all continued motor activity.

⁶G. Lefmann, Ueber psychomotorische Störungen in Depressionszuständen, *Psych. Arbeiten*, IV, 1904, 601-668.

Subjects	TABLE III FATIGUABILITY OF SUBJECTS IN TERMS OF INDEX		TABLE IV WEIGHT-DISCRIMINATION TEST			TABLE V NUMBER-CHECKING TEST. TIME EXPRESSED IN SECONDS		TABLE VII DISTRACTION TEST. TIME EXPRESSED IN SECONDS	
	Right Hand	Left Hand	Order of Arrangement	No. of Dis- placements	Coefficient of Correlation	1st Trial	Aver- age and Trial	1st Trial	Aver- age and Trial
						123.0	134.0	123.0	139.5
Normal: 20 College men... 20 College women.									
Pr. I.....	90.2	82.8	A B C D E F G H I J K L	6	+05	167.8	166.2	83.8	78.8
Pr. II.....	90.0	78.7	A B C D E F G H I J K L	8	95	284.8	188.2	69.9	75.3
Pr. III.....	95.3	98.1	A B C D E F G H I J K L	12	92	181.0	168.0	74.0	73.0
Depressed: Hi.....	102.0	97.3	B A C D E F G H I J K L	8	96	.....	.....	163.3	121.9
Pr. I.....	90.3	81.3	A B C D E F G H I J K L	8	91	225.0	189.0	80.0	82.0
Pr. II.....	.....	.....	A B C D E F G H I J K L	14	88	274.0	.....	125.6	117.0
Pr. III.....	.....	.....	A B C D E F G H I J K L	14	85	957.0	507.9	126.9	130.0
Bu.....	93.2	84.1	B A C D E F G H I J K L	14	85	.....	.....	.....	.....
Manic: Fr. I.....	85.3	89.4	A B C D E F G H I J K L	10	91	b	170.0	.....	68.0
Fr. II.....	85.3	89.4	A B C D E F G H I J K L	10	98	188.0	158.0	82.0	76.5
Wa.....	89.3	86.8	A B C D E F G H I J K L	4	98	.....	.....	410.2	250.9
Sh.....	93.8	81.7	A B C D E F G H I J K L	8	96	.....	.....	795.8	.....
Wi.....	90.8	88.0	A B C D E F G H I J K L	20	93	48.4	284.8	142.8	.....
Pr. I.....	120.8	88.3	A B C D E F G H I J K L	10	98	102.0	181.2	124.0	95.0
Pr. II.....	120.8	88.3	A B C D E F G H I J K L	10	98	250.0	188.4	124.0	88.8
Pr. III.....	99.2	90.0	A B C D E F G H I J K L	16	88	214.2	105.0	84.7	82.5
Re.....	99.2	90.0	A B C D E F G H I J K L	16	82	188.0	183.0	80.7	80.2
Go.....	89.4	84.3	A B C D E F G H I J K L	14	88	b	247.4	63.2	45.0

a Eyesight very defective. Little reliance can be put on these figures.

a On basis of 507.0 alone. See notes.

b Watch stopped.

c Time actually spent in marking; not including five stops to rest the eyes.

a Total number of places displaced.

b Total number of displacements squared.

3rd. There is as much evidence for "interserial warming-up" in the left hand as in the right. (See Table II.)

b. *Relations within the Single Series.*—Table III presents the fatiguability of the subjects in the tapping test. The indices (f) used here are those advocated by Wells and are computed as follows: The average of the second to the sixth five-second periods is divided by the first five-second period. A perfectly steady tapping record would thus give a record of 100. Anything below 100 indicates fatigue and anything above 100 indicates an increase in the tapping-rate during the period. Wells found for the average of ten normal subjects the following indices: right hand 93.5, left hand 88.8. In normal individuals it practically never occurs above 100. The average indices obtained from my three normal records agree very well with these, being 91.8 for the right hand and 86.5 for the left. But one of the individual records varies considerably from these averages. This record of Po. (95.3 and 98.1) taken just before her discharge from the hospital is rather high, especially for the left hand.

For depressed subjects, Wells reports 98 and 93 as the indices respectively for the right and left hands. As these indices are considerably above the normal records it means that such subjects show less fatigue (reversal) than normal subjects. This abnormal presence of reversal is one of the essential phenomena of retardation according to Wells. But only two of his twelve subjects have indices for both hands of 100 or over, while five more have such indices for one hand. This leaves five out of the twelve who had indices in both hands below 100. Of the three depressed subjects whose records we have, two are like normal subjects and one (Hi., i. e.,—102.0 and 97.3) shows a gain in the tapping-rate in the right hand and an almost steady tapping-rate in the left. This latter record clearly shows "retardation," i. e., the inability to respond promptly to a stimulus coupled with a marked tendency to increase in proficiency as the response is repeated. It is this tendency to increase in speed coupled with the low initial performance which gives us such an index as 102. Kraepelin⁷ emphasizes that the three fundamental symptoms of the depressed state are (1) associative retardation or thinking disorder (*Denkhemmung*), (2) motor retardation (*Willenshemmung*), and (3) depression (*Verstimmung*). Now the characteristic feature of the clinical picture of Pr's. and Bu's. attacks is the depression, while that of Hi's.

⁷ E. Kraepelin, *Psychiatrie*, 7th ed., Vol. II., Chap. IX.

is the retardation. We cannot be sure from a clinical analysis that the first two subjects do not have some retardation. But the depression is so prominent that it does not allow the lesser symptom to be manifested. The tapping test, then, bears out the clinical analysis entirely, in that it shows that Pr. and Bu. are not particularly retarded but that Hi. is.

With the manic subjects we find the first four to be normal in type. The high index for Wi. in the right hand is due to the first two records which were quite high (105 and 99), the other three were normal (94, 94 and 94). The next two subjects, Po. and Re., are above the normal,—Po. with the right hand in the first test and with both hands in the second test and Re. with the right hand. The indices from Po. when she was normal, as previously pointed out, are above the normal, especially with the left hand. It is consequently difficult to say whether the abnormally high indices for her sick as well as her normal condition are due to an individual idiosyncrasy or whether there was really some retardation present in her case, even when well, which was augmented when sick. The latter explanation would be supported by the findings of Gross and Lefmann. The former found in manic cases that during remissions there is a more or less considerable psycho-motor retardation with which can be associated a difficulty of elementary thinking processes. As already mentioned, the latter reports from his study of mixed cases, to which Po. belongs much more than to that of the pure manic state, that they seem to exhibit retarded symptoms in initiating each new movement but manic symptoms during the movement. Gross finds this same condition in those mixed cases which clinically stand near to the manic. The mixed case may then exhibit both retarded and manic symptoms at the same time. Po. clearly shows this; for she exhibits little or no fatigue in these tests on all three days (barring the first trial with her left hand), the first when manic, the second when "drifting" and the third just before her discharge. In this she resembles retarded subjects. At the same time she showed unmistakable increasing excitement from series to series on her first day, and a record in this respect above the normal on the other two days—a clearly manic condition.

The results from Go. are normal, or possibly below the normal.

Retardation is indicated here in 3 of the 11 subjects;—One (Hi.) who was clearly retarded according to the clinical picture, one (Po.) who was primarily in a manic condition

but showed clinically at times associative retardation, and one (Re.) (only in the record of one hand) a pure manic subject. None of the other subjects are retarded as far as can be ascertained clinically or experimentally.

c. *The Tapping Rate*.—Marsh⁸ and Hollingworth⁹ both find an increase in the tapping rate at night over that of the morning or afternoon. In explanation of this difference in tapping rate, the former states, "it is suggested that rapidity of tapping, as it requires a minimum of control but a maximum of neural excitement, may be expressive largely of 'nervousness.'" Marsh found a decrease of control (in steadiness test) at night to support this view. But Hollingworth finds the opposite in the same test. The matter cannot be settled at present but it does seem probable that increase of tapping rate under certain conditions may be expressive of excitement, irritability, or 'nervousness.'

My results seem to bear out some such hypothesis. Thus there is a marked decrease of tapping rate in the case of Po., a manic subject, as she improved. Her three tests were taken when she was 1st, much excited, 2nd, little excited, and 3rd, normal. The average number of taps per five seconds on the three occasions were, respectively, 31.0, 26.4, and 25.4 for the right hand and 27.7, 24.1, and 24.6 for the left. Here there is a noticeable decrease in tapping rate as her manic condition subsided. With Pr., a depressed subject, we obtain the opposite tendency. Her three tests were taken when she was 1st, "no symptoms," 2nd, normal, and 3rd, quite depressed. Her average numbers of taps on these occasions are 32.9, 32.1, and 29.8 for the right hand and 28.3, 27.3, and 25.5 for the left. Wells' results agree with these, showing that the normal subject taps faster than the depressed. His figures are 194 and 175 taps in 30 seconds for the two hands with normals as against 170 and 159 for depressed subjects. This decrease in gross tapping rate is his third criterion of motor retardation. Case III in his article in the *American Journal of Insanity* also showed a "tendency for the gross rate to be faster on good days and lower on poor ones." On the other hand, his manic subjects showed a higher initial rate than normal. Moreover, the more pronounced manic states seemed also to have a higher initial rate than the less pronounced. He states more specifically as follows:

⁸H. D. Marsh, *The Diurnal Course of Efficiency*, *Col. Cont. to Philos. and Psychol.*, XIV, No. 3, 1906.

⁹H. L. Hollingworth, *The Influence of Caffeine on Efficiency*, *Col. Cont. to Philos. and Psychol.*, XX, No. 4, 1912.

"When the psychological measure can be made sufficiently independent of special factors of co-operation it is probable that the optimum performance of manic states is quite superior to the normal as well as the depressed."

Gross found that his retarded cases were slower than the normal in the writing while the manic cases were much faster, except at the start when they were not much different from normal subjects.

Results based upon two subjects of opposite tendencies would not have much weight if standing alone. But considering that these results of mine agree with previous work, I may fairly conclude that in the manic state the rate of tapping is increased over that of the normal condition for that subject, while the reverse is true for the depressed state.

2. *Discrimination of Weights*

Eleven weights were used. The lightest one, marked A on the back, weighed 100 grams. The remaining 10 formed a geometrical series, each being 104% of the former. This series was prepared by Wells with great care. According to this arrangement B weighed 104 grams, C 108.16, D 112.48 + etc., until K weighed 148.02 + grams.

The weights were arranged in chance order in a row between the subject and experimenter. Starting at the right hand end the first two weights were presented to the subject and she was directed to indicate which was the heavier after having lifted each weight with her right hand. In those cases when she reported that they were equal she was directed to guess as to which was the heavier. The heavier weight was then put to the right and the lighter one was compared with the third in the row. In this way the heavy weights were directed to the right end of the row and the light weights to the left end. This process was continued until all the weights had been judged to be heavier than the weights to their left. The record was recorded by jotting down in order the letters on the bottom of each weight.

A side issue to the main problem of this report but connected with the technique of this test is worth noting in passing. As has been stated our series of 11 weights form a geometrical series in which the increment is 4%. Such a series was advocated by Galton¹⁰ and has been used by Spearman.¹¹ It would conform, as Galton states it, to a

¹⁰ F. Galton, *Inquiries into Human Faculty*, Appendix C to Everyman's Library edition.

¹¹ C. Spearman, General Intelligence Objectively Determined and Measured, *Amer. Jour. Psychol.*, XV, 1904, 201-293.

geometric series: "thus— WR^0 , WR^1 , WR^2 , WR^3 , etc."—where W equals 100 grams and R equals $26/25$. "It follows that if a person can just distinguish between any pair of weights he can also just distinguish between any other pair of weights," whose intervals in the series differ by the same amount. In other words, this series of ours should give us equal "sensation-steps." But the results show very clearly that we do not get any such arrangement. The last two lines in Table IV present a summary of the displacements of each weight from its correct position in the arrangements of the 16 subjects. There is undoubtedly an increase in the tendency to displace the weights as one proceeds from the lightest weight to the heaviest. Weights A and B were displaced on an average $8\frac{1}{2}$ places by the 16 subjects, Weights C, D, E, and F, $12\frac{1}{2}$ places, and Weights G, H, I, J, and K, 20 places. If greater emphasis is placed upon the amount of displacement, as for example, by squaring the number of places displaced, we have the figures in the last row of the table. The irregularities in the results are probably due to the small number of cases. But it does seem certain that there is at least twice the tendency to confuse Weights K and J as there is to confuse B and A. Weber's Law does not then even approximately hold here. To secure a series with fairly constant "sensation-differences" means the construction of a series whose increment shall also increase.

The results from the Weight Test are given in this Table. After the name of the subject is given the actual order of arrangement of the weights by that subject. Following this order is given (1) the total number of displacements in the given order from the correct order and (2) the coefficient of correlation between the given order and the correct order. The first figure has often been used as a measure in such procedures. But it seems to the writer that a displacement of one of the weights with its neighbor, resulting in a score of 2 (as both are then displaced), is very much less serious than when a weight is two places removed, resulting in a score of 4. If the displacements were squared and then totaled the results would more nearly present the true situation. When a coefficient of correlation¹² is obtained these displacements are squared during the computation, hence there is no need to present both the squared displacements

¹² Using Pearson's Rank-Differences Formula, $1 - \frac{6 \sum (d^2)}{n(n^2-1)}$

and the correlation coefficient. The latter is given because of its better known character.

As the subjects are grouped there does not appear to be any significance between the type of attack and the results in this test. The three normal results correlate + 92 or higher. Five subjects correlate below + 90, i. e., Ha. and Bu. (depressed), Wi. and Re. (manic), and Go. It is true that the symptoms of the first two are somewhat different from Pr. or Hi., our other depressed subjects. Hi. is primarily retarded. Pr. is depressed with especial dullness of the head, while Ha. and Bu. are depressed with feelings of loss of affection and numbness and deadness of the body. The nerves are thought of as "dead" and the body as "if there were no insides to it." This additional loss of feeling in the body may account for the poorer showing in this test of these two subjects. The poor showing of Wi. and Re. may possibly be due to a "flightiness" of attention,—a common characteristic of manic subjects. But nothing of the sort was noted at the time of the experiment which differentiated them from the others. No cause for Go's. poor showing is suggested.

Wells¹³ carried on a similar experiment with six weights, weighing 51, 53, 55, 57, 59, and 61 grams, respectively. He had 10 subjects, among whom 4 were normal and 4 depressed. No difference was found between these two groups when the averages were compared. But two of the four depressed gave results much below those of the others.

Such work as has been done on sensory discrimination with manic-depressive or other allied types of insanity all goes to indicate that there is no serious defect present. A few exceptions have been noted by Janet, Alter, and Hoch.¹⁴

Franz and Hamilton, more recently, report for one retarded case a 10 to 15 per cent. lowering of the touch threshold on those days on which the subject was subjected for five minutes to mechanical vibration along the spine. This report suggests that there is a relation between lack of feeling or discrimination and sensory capabilities.

It seems then that some insane subjects do poorly in this test. But the relationship between the form of attack and the experimental results is not at all clear.

¹³ F. L. Wells, On the Variability of Individual Judgments, *Essays Philos. and Psychol. in Honor of Wm. James*, 1908.

¹⁴ A. Hoch, A Review of Some Recent Papers upon the Loss of the Feeling of Reality and Kindred Symptoms, *Psychol. Bull.*, II, 1905, 233-341.

3. *The Number-Checking Test*

This is the Cancellation test recommended by Woodworth and Wells.¹⁵ It consists of a blank with 20 lines of numerals. Each line has each one of the 10 numerals (0 to 9) repeated five times. The subject was instructed that there were five O's in each row and that she was to go through all the rows and mark each O. She was to do this as fast as possible and yet she was not to miss any of them. The emphasis was placed equally on speed and accuracy in the instructions.

The results from the number-checking test are given in Table V. At the top of the Table are given the results from 40 college students, 20 of each sex.¹⁶ Under these results are given the results from the three normal records, and the other subjects follow in the usual order. The first column of data gives the results from the first test, the second column gives the results from the second test made a few minutes later. The third column gives the averages of these two results.

In those cases where only one reliable result was obtained, instead of two, the result in the average column was computed on the basis of that reliable result. The average practice effect of the group, where two valid results were obtained was as 100 to 85. The missing result was computed on the basis of this ratio and then averaged with that result to give the average. Such a procedure is rather risky, but for the purposes of this experiment it is better to be able to compare all the subjects together on some common basis than to be forced to omit several from consideration.

The results are stated in terms of the time taken up in cancelling the 100 O's in the blank. Omissions were computed as follows. The time was found for cancelling a single O. Then twice this time was added to the recorded time for each omission except when a whole line was omitted. Then only five times (there being 5 O's in a line) this amount was added instead of twice the five. The reason for this procedure was that when a line was skipped it was due to accident and hence it would probably have taken only as long to cancel the O's in it as it did to cancel the other lines. But when an O was missed in a line it meant that the subject had lost count in the line or that not finding the O she had gone on rather than gone back to find it. Such an O would un-

¹⁵ R. S. Woodworth and F. L. Wells, Association Tests, *Psychol. Monog.*, No. 57, 1912.

¹⁶ *Ibid.*

doubtedly have taken longer to cancel than the average O cancelled. Twice the average time seems a reasonable allowance in this case. Wrong cancellations were not scored, there being only one such case, except in the case of Bu. Her case is considered separately below.

The three depressed subjects are slower in performing this test than are the two normal subjects. Four of the manic cases are no slower than the poorest normal record (of Pr. II) but they average somewhat slower than the average of the normal records, i. e., 186.3 as against 179.3. This is not much of a difference and should probably not be considered. The other two manic cases, Sh. and Po. I and II are slower than the poorest record of the two normal subjects, the former by 140.1 seconds and the latter by 22.7 and again by 8.1 seconds.

TABLE VI

SHOWING RELATIONSHIP BETWEEN RESULTS IN NUMBER-CHECKING
TEST AND CHANGES IN THE ATTACK

Subject	Conditions	1st Trial	2nd Trial	Average
Pr. I.....	"no symptoms".....	167.8	166.2	167.0
II.....	normal.....	204.8	188.2	196.5
III.....	depressed.....	225.0	189.0	207.0
Po. I.....	manic.....	250.0	188.4	219.2
II.....	manic.....	214.2	195.0	204.6
III.....	normal.....	181.0	168.0	174.5

The records of Pr. and Po. are separated out from Table V and are presented in Table VI. Here we have their records when they were normal compared with their records when sick. Pr. was normal during the first two tests and then depressed at the time of the third test. Instead of a practice effect as a result of the six tests we have the opposite effect shown on the three different days; but there is a practice effect between the two trials on the same day. One should expect an improvement in the second day's test over the first, as she was normal at both times. If it was not for this peculiarity, one would be warranted in attributing the lack of improvement on the third day to the depression. As it is, no conclusion can be reached. Po., on the other hand, was manic during the first trial, in a mixed condition during the second and normal during the third. Here there is a practice effect shown throughout the series of tests. But there is much

greater improvement shown in the third day's work over the second than in the second over the first. The normal thing would be to find a greater improvement between the second and first than between the third and second. From her case it would seem that the manic attack interfered with and slowed up her performance in this test.

Subject Bu. reacted to this experiment in a rather peculiar manner. She consumed 8 minutes and 48 seconds in the first trial. Exactly 2 minutes were spent in checking the first two lines and here I helped her chiefly by encouraging her to go on. She seemed rather lost, not knowing what to do, and yet I am as sure as one can be that she really understood what was wanted. Despite the amount of time consumed in these two lines she marked but 4 O's in each line. She then commenced to go faster but to make many mistakes. Her record by groups of 4 lines is as follows:

1st four lines	7	omissions	and	4	wrong symbols	checked.
2nd " "	7	"		6	" "	"
3rd " "	11	"		3	" "	"
4th " "	10	"		1	" "	"
5th " "	0	"		0	" "	"

We have here a quite decided practice effect in accuracy, and although the time was not taken for the different portions of the test sheet my impression is that there was a quickening of the speed of work. The second test was performed in 2 minutes and 54 seconds less time, with no wrong symbols checked and with but 20 omissions instead of 30. There again there was a decided decrease in the number of mistakes, especially in the last 4 lines where but one was made. Both tests picture initial retardation while the first test adds also a picture of confusion and difficulty of performance.

Franz,¹⁷ basing his conclusions upon a similar experiment, reports that both the depressed and excited subjects were slow as compared with the normal at the commencement of a period of practice.

Basing our conclusions upon all the results it seems very probable that both depressive and manic attacks interfere with performance in the cancellation test. The interference does not affect the accuracy of the work ordinarily but does increase the time of performance.

The cancellation test, while it brought out some results, was

¹⁷ S. I. Franz, The Time of Some Mental Processes in the Retardation and Excitement of Insanity. *Amer. Jour. Psychol.*, XVII, 1906, 36-68.

far less satisfactory than it might have been. The figures on the test-blank are altogether too small and the lines are too close together. If the lines were "leaded" much of the tendency to skip lines would be eliminated. Several of the subjects had to be excused from the test because of inability to distinguish the numerals apart. Still others occupied a large part of the time in processes of seeing. But with a blank of larger print, I believe we should have here a very valuable test for such subjects. By timing the cancelling of each fifth of the blank, considerable insight as to mental retardation might be obtained.

4. The Distraction Test

Fifty postal cards were selected, composed of ten each of such types of pictures as:—scenery, public buildings, portraits, kissing pictures, etc. At the lower left hand corner of each card was pasted a small numeral. Five numerals were used, from 1 to 5. Two cards from each of the five groups were given the same numeral. The subject was seated before a table and before her were placed five slips of paper with the five numerals upon them. Numeral 1 was to her left and the others followed in serial order to the right. She was instructed to take the pack of 50 cards and to sort them according to the small numbers in the lower left hand corners. All the cards with a "1" upon them were to be placed on the pile at the extreme left, all the "2"s on the next pile, etc. Every precaution was taken to insure that each subject understood exactly what was wanted and also that we were timing her. The experimenter watched the sorting and whenever he noticed a card being placed on the wrong pile, he called attention to it and had the error rectified. The errors recorded in the results are errors that were not thus caught and rectified during the timing. It is fair to state, then, that the emphasis was upon accuracy rather than speed in this test, although all knew that they were being timed.

The purpose of the test was to determine whether the subject could concentrate her attention upon the work in hand even when a new picture was being presented on each card. It was believed that observation of the conduct of the subject would determine very largely the cause of noticeable slowness of performance, if any developed. That is, whether the slowness was due to motor trouble, or to distraction due to the pictures on the cards, or to other causes.

The results from the test are given in Table VII. The first and second trials and their average are presented in the

three columns. The practice effect of the two trials gives a ratio of 100 to 81. On that basis the time was computed for the first trial of Fr. (the time having been lost as a result of the failure of the stop-watch) and the two results were then combined for the average. The results for Wa. are very unreliable as she could scarcely see the figures on the cards. A second trial was not attempted with Sh. as she was unwilling to co-operate properly. A proportionate amount of time was added for each mistake.

For all but two subjects, as far as could be judged by closely watching the subjects, the test resolved itself into one of motor ability plus co-ordination of eye and hand. But with Sh. and Wi. there was very pronounced distraction. The latter noticed the pictures as she sorted the cards and commented about them. During the second trial she apparently ignored all but the kissing pictures. These she still continued to observe. In reference to these she said during the first trial, "They're funny; you must give me one when you get through." And after the second trial she held up three and asked for at least one of them. A moment later she asked to be excused for a few minutes, having stuffed one into her dress. When I granted her request but insisted that she give up the card, she gave it up and settled back in her chair. Sh. placed the kissing pictures at the back of the pack instead of upon their several piles. In this way she retained them after having sorted all the others. She then continued to look at them and place them at the back of the pack. Only after considerable urging on my part was she finally led to sort them. Only one trial was made in her case because of lack of time—the trial having consumed 13 minutes and 15 seconds. Our clinical picture does not suggest any reason why Sh. should have responded to the kissing pictures any more than the other subjects. But with Wi. it is different. Her conduct, when normal as well as when sick, indicates that this sort of thing is uppermost in her mind. As will be pointed out under the association-test many of her association responses were strikingly of this nature. It is very probable then that she was distracted not because of any mental defect but rather because the particular distraction was peculiarly of interest to her. Sh., on the other hand, was not only interested in the pictures but was carried away by them, losing all interest in the experiment. Only by continued exhortation could she be led to finish the test. In this she showed an abnormal condition, entirely lacking in Wi.

As already emphasized, this test is not actually one of dis-

traction, but rather one of motor ability and co-ordination of eye and hand. By "distraction" I have meant here the tendency to look at the pictures on the card rather than the numerals. Of course, there is "distraction" present here, if distraction is thought of as the opposite of attention. It is not surprising then that the results from this test are similar to those of the cancellation test. Both of them are tests of perception and motor response. In the cancellation test perception is more prominent than the response; in this distraction test the two factors are reversed in importance, there being five responses instead of one.

TABLE VIII

SHOWING RELATIONSHIP BETWEEN RESULTS IN DISTRACTION TEST AND CHANGES IN THE ATTACK

Subject	Conditions	1st Trial	2nd Trial	Average
Pr. I.....	"no symptoms"....	83.8	78.8	81.3
II.....	normal.....	69.9	75.3	72.6
III.....	depressed.....	89.0	82.0	85.5
Po. I.....	manic.....	124.0	88.8	106.4
II.....	manic.....	84.7	80.2	82.5
III.....	normal.....	74.0	73.0	73.5

Here again the depressed subjects are slower than the normal subjects. The third trial of Pr., when depressed, is not so much slower than her normal records or that of Po. but the fact that she is slower is important as practice should have made her faster. Table VIII presents her three records together and shows this decrease in efficiency when depressed more clearly than in Table VII. Comparison of the depressed subjects, except Pr. who had had two previous trials, with the manic cases shows that they are all considerably slower than the manic subjects. (The record of Wa. cannot be considered as it was due to her poor eyesight.) The difference is enough to warrant a conclusion that depressed subjects are slower than either normal or excited cases. Of the four depressed subjects, Hi. is much the slowest. The clinical picture and the tapping test both have shown that she was "retarded." Her average time was from 14 to 21 seconds slower than that of Bu. and Ha. Both of them, moreover, were troubled with handling the cards. Besides this difficulty, Bu. was troubled in locating the correct pile. After she had the next card in

her right hand, she would look at the piles for some time before choosing the correct one. Then she would place the card upon it in a very deliberate manner. Motor control then was faulty in all the three. In addition, Bu. had mental retardation.

Three of the five manic cases that can be considered are as fast as our normal subjects. Wi. is slower because of the distraction already referred to. Po. is very slow in her first trial of the first day (124 sec.). Her second trial on that day (88.8 sec.) is not very much longer than the other normal or manic subjects. Table VIII gives her records together. There we see very consistent improvement in the 6 trials on the three different days. Whether there is greater improvement due to her accompanying improvement in mental condition than would take place if she had been normal on all three days cannot be determined. The relationship between normal and manic condition in this cannot be settled from the data.

Go. gives the fastest results of all the subjects including the normal ones (63.2 and 45.0). A number of tests on college men gave 60-65 secs. for the first trial and 50-45 secs. for the second. Her record must be considered as good as can ordinarily be obtained. All of the tests show that she had good motor control, although she was a cripple and of inferior constitution. However, she tired faster than ordinarily in the tapping test.

CONCLUSION:—Depression results in a noticeable decrease in speed in this test. The records of depressed subjects are slower than either normal or manic cases. No conclusion is warranted from the data concerning the difference between manic and normal conditions.

5. *The Association Test*

This is the familiar association test in which the subject is instructed to give the first word that occurs in response to a given stimulus-word. The list of 100 words used was that recommended by Kent and Rosanoff.¹⁸ Their method of procedure and treatment of data were followed throughout, except that in addition the time of each response was taken. They present the results obtained in this test from 1,000 normal individuals and 247 insane patients. They record the number of times any response was given to each of the 100 stimulus-words by these 1,000 normal subjects. On the basis of these

¹⁸ G. H. Kent and A. J. Rosanoff, *A Study of Association in Insanity*, *Amer. Jour. Insanity*, LXVII, Nos. 1 and 2, 1910.

frequency tables they divide all responses into three groups:—common, doubtful, and individual. The *common* consist of such responses as were given by 1 or more of their 1,000 subjects. The *doubtful* consist of “any reaction word which is not found in the tables in its identical form, but which is a grammatical variant of a word found there,” as “govern” and “governed.” The *individual* reactions consist of such responses as were not given by any of their 1,000 subjects. The “individual” responses may be “normal” or “pathological;”—*normal* when the response is perfectly normal in every respect, but did not happen to be given by any of the 1,000 subjects; *pathological* when the response is not thus

TABLE IX
DISTRIBUTION OF ASSOCIATION-REACTIONS OF NORMAL AND
INSANE SUBJECTS

Type of Response	From Kent-Rosanoff Tables			Our data
	1000 normal subjects	247 insane subjects	32 manic depressives	16 manic depressives
Common.....	91.7	70.7	75.8	78.6
Doubtful.....	1.5	2.5	3.0	1.0
Individual.....	6.8	26.8	21.5	19.7
Failures to respond...	0	0	0	.7

TABLE X
DISTRIBUTION OF “INDIVIDUAL” REACTIONS OF MANIC-DEPRESSIVE
SUBJECTS

	Kent-Rosanoff	Our data
Normal.....	5.3	5.5
Sound reaction.....	1.5	.2
Word complement.....	.2	.7
Association to preceding stimulus...	.5	.7
Association to preceding reaction...	.4	1.8
Repetition of preceding stimulus...	.0	.1
Repetition of previous stimulus....	.2	.2
Repetition of preceding reaction....	.8	.1
Repetition of previous reaction....	.9	.4
Unclassified.....	8.6	10.0
Other groups.....	3.1	.0
Total.....	21.5	19.7

normal. Their totals are presented in Table IX. Here we have their total results from (1) 1,000 normal subjects, (2) 247 insane patients, and (3) 32 manic-depressive subjects. Alongside the latter are presented our results. It is evident that the two investigations agree very closely. A comparison of their results and ours when based on the medians instead of averages gives equally close agreement. Table X presents the sub-groups under "individual" reactions. Kent and Rosanoff's results are found in the first column and ours in the second. Here again there is very close agreement. Indeed, throughout all the details that we have considered, there has been a corresponding agreement. Their summary¹⁹ applies here equally well:—"In this disorder the departures from the normal seem to be less pronounced than in the other psychoses considered." The number of "individual" reactions is in most cases not greatly above the normal average; and, so far as their character is considered, we find that many of them are classed as "normal," in accordance with the appendix to the frequency tables; among the "unclassified" reactions, which are quite frequent here, we find mostly either obviously normal ones, or some of the type to which we have already referred as "far-fetched," while others among them are "circumstantial."

Table XI presents the detailed results for each subject. Among the 1,000 normal subjects studied by Kent and Rosanoff, there are 53 which they report as having an average of 21.8 (median 21) "individual" reactions. All of the 53 had 15 or more "individual" reactions. It is evident then that 53 normal subjects in 1,000 have 15 or more "individual" reactions and that about 25 in 1,000 have more than 20 such reactions. Our three normal records average 6.3 "individual" reactions, our depressed subjects (excepting Bu.) average 9.7, and our manic subjects average 16.1. Subjects Bu. and Go. display such striking differences from the other subjects that they must be considered by themselves. As, however, Bu. is a depressed subject, it is only fair to give also the average of the depressed subjects including her. This average is 27.3. The subjects who have 15 or more "individual" reactions are Fr. (both records, 22 and 23), Wa. (20) and Re. (31, all manic subjects, Bu. (80) a depressed, and Go. (59). Sh., Wi., and Po., all manic subjects, have but from 5 to 10 "individual" reactions. We cannot postulate any difference here between normal, depressed, and manic

¹⁹ *Ibid.*, p. 53.

TABLE XI
TYPE OF ASSOCIATION-REACTIONS OF EACH SUBJECT

	INDIVIDUAL REACTIONS											Failures	
	Common	Doubtful	Normal	Sound Reactions					Unclassified	Total Individual			
				Word Complement	Association to Preceding Stimulus	Association to Preceding Reaction	Repetition of Preceding Stimulus	Repetition of Preceding Reaction			Repetition of Preceding Stimulus		
Normal:													
Pr. I.	91	...	6	...	...	...	...	...	...	...	2	8
Pr. II.	90	2	1	1	...	...	...	...	...	...	6	8
Pr. III.	97	...	3	...	...	...	...	...	...	...	...	3
Depressed:													
Pr. I.	91	1	7	...	...	...	...	...	...	...	1	8
Pr. II.	81	...	3	...	1	...	...	...	...	1	4	9
Pr. III.	85	...	3	...	...	...	...	...	...	...	7	12
Ma.	...	...	...	...	...	...	...	...	...	...	...	3
Bu.	19	...	0	6	18	...	...	2	...	2	40	86
Manic:													
Pr. I.	78	...	3	4	...	...	...	...	...	...	13	22
Pr. II.	72	...	0	...	...	1	...	...	1	1	7	23
Pr. III.	77	...	11	1	...	...	...	...	...	8	20	5
Wa.	...	3	...	...	...	...	...	...	...	...	4	10
Sh.	89	1	5	...	...	...	...	...	...	1	1	8
W.	...	...	...	1	...	...	...	...	...	...	...	...
Pr. I.	90	2	5	...	...	...	...	...	...	1	4	10
Pr. II.	87	3	0	...	...	...	...	...	...	...	...	...
Pr. III.	95	...	1	...	...	...	...	...	...	...	...	5
Re.	67	2	10	2	...	2	...	1	...	1	16	31	
Go.	38	2	13	2	...	6	...	...	...	...	38	59
Average	78.6	1.0	5.6	.2	.7	1.8	.1	.21	.4	10.0	19.7

TABLE XII
ASSOCIATION REACTION-TIME OF EACH SUBJECT, IN SECONDS, WITH P.E. OF DISTRIBUTION

	Common		Normal		Word Complement		Association to Preceding Stimulus		Association to Preceding Reaction		Unclassified	
	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.	Med.P.E.
Normal:												
Pr. I.	9.8	3.1	25.0	9.5	...	...	...	...	...	...	...	...
Pr. II.	8.0	2.1	...	...	...	...	...	...	...	...	...	...
Pr. III.	7.9	2.2	...	...	...	...	...	...	...	...	...	...
Depressed:												
Pr. I.	18.0	9.3	19.3	5.3	...	...	...	...	...	...	...	...
Pr. II.	8.7	2.4	...	...	...	...	...	...	...	...	...	...
Pr. III.	15.3	8.3	...	...	...	...	...	...	...	...	...	...
Ma.	12.3	5.0	21.0	13.5	...	...	6.0	27.0	6.3	3.0	...	...
Bu.	...	...	...	...	...	...	...	...	...	...	...	...
Manic:												
Pr. I.	18.3	8.1	...	...	...	...	...	...	...	...	...	...
Pr. II.	15.3	5.0	21.0	11.5	12.3	6.2	...	...	...	...	...	...
Pr. III.	11.3	2.0	20.7	7.2	...	...	...	...	...	...	...	...
Wa.	27.0	17.4	20.0	20.5	...	...	...	...	...	...	...	...
Sh.	12.3	3.2	18.0	3.3	...	...	...	...	...	...	...	...
W.	8.7	2.3	15.0	6.1	...	...	...	...	...	...	...	...
Pr. I.	8.1	2.8	...	...	...	...	...	...	...	...	...	...
Pr. II.	9.9	2.2	13.5	3.9	...	...	...	...	...	...	...	...
Pr. III.	...	...	...	...	...	...	...	...	...	...	...	...
Re.	18.5	14.7	23.0	5.8	...	...	...	...	...	...	...	...
Go.	...	...	...	...	...	...	...	...	...	...	...	...
Average	12.0	14.4	20.0	15.5	...	...	...	...	...	...	...	...

subjects except that the normal do not show as great a number of "individual" reactions as do *some* of the depressed or manic subjects.

Table XII presents the median time of the reactions of the different subjects. The probable error of the distribution is also given in order to enable one to grasp the amount of variability in the times of any group. Only the sub-groups of Table XI are given here in which there were at least 6 cases. A central tendency based on 6 cases is not very reliable except where the probable error is low. Grouping the subjects together, we have an average time for the normal subjects of 8.6 fifths of a second, 13.6 for the depressed, and 13.9 for the manic. These averages seem to indicate that both depressed and manic subjects are slower than normal subjects. But as four of these twelve abnormal records are as fast as Pr. I, it seems best merely to state that taken as a whole normal subjects are faster than either depressed or manic subjects, but that some individual depressed or manic subjects may give records as fast as normal subjects.

Let us consider the individual cases. The first two records on Pr. were when she was practically normal, the third record when she was depressed. No difference appears in the total number of reactions in any group. The time for the "common" reactions is a trifle slower in her third test than the second, but it is faster than her first test. No deduction can be made from such data, except that the depressed condition has not appreciably lengthened her reaction-time. With Po., the first two tests were made when she was manic, while the third was taken when she was normal. There is some improvement both in the increase in the number of "common" reactions given and in the decrease in the time of the reactions. But most of the improvement takes place between the first and second test when she was still manic. The improvement cannot be ascribed to her improvement in condition with any certainty. It may be only due to practice.

Fr. shows some difference in her reactions at the time of her two tests. The second record is the poorer. There is a decrease of 6 in the number of "common" reactions, an increase of 3 in the "normal" reactions and a substitution of 6 "sound" reactions for 6 "unclassified" ones. From the clinical picture we learn that she was much more easily excited at the time of the second test, getting quite angry and breaking glass. Whether or not there is any relationship between the poorer record and her increased excitement cannot be answered here.

The records of Bu. and Go. in Table XI are quite similar. Only by a study of the reaction times and a careful scrutiny of the separate reactions can one decide that they are totally different in kind. Of the 19 "common" reactions of the former 9 were reactions which only one subject of the 1,000 had given as shown in Kent and Rosanoff's frequency tables. Two of these nine would be classified as "associations to preceding reactions" and two more as "unclassified," if they were not grouped under the heading of "common." Bu. then gave very few "common" or "normal" reactions. She gave 18 "associations to preceding reaction" besides the two above, and 6 "associations to preceding stimulus." These 18 and 6 had median times respectively of 6.3 and 6.0 fifths of a second. The "common" took twice as long (12.3) and the "normal" three and a half times as long (21.0), while the "unclassified" took only $\frac{2}{3}$ more time (10.0). It seems fair to conclude that Bu. carried on a train of thought connecting the reaction-words and responded from that train of thought to the stimulus words. Such a conception would account for the large number of "associations preceding reactions" and their very quick time. The "unclassified" words also probably belong to this class, but here the connection between the given word and what had gone before was not obvious to the experimenter. The "common" and "normal" reactions may be accidents, or what is more likely to my mind is that the train of thought was broken at these points and she gave true responses to the stimulus-words. In any case the most favored response for her was the "association to preceding reaction" while the "normal" was the least favored, with the "common" intermediate between the two.

Go., on the other hand, had 38 "common" and 59 "individual" reactions. Of these 59, 38 were "unclassified." The "common" were the fastest (18.5), the "normal" next (23.0) and the "associations to preceding reaction" and "unclassified" were the slowest (29.0). There was no train of thought here but simply an extreme example of the tendency to give "unclassified" reactions which are largely incoherent. We should conclude that Go. is one of those cases whose test-records, according to Kent and Rosanoff, "strongly resemble, in some respects, those of dementia praecox." Bu. might also be included under this heading if the type of response is alone considered, but if the reaction-time is also considered we must place her elsewhere.

Considered as groups, normal subjects give fewer "indi-

vidual" reactions and respond much more quickly than do depressed or manic subjects, but some individual depressed or manic subjects give records indistinguishable from normal. As groups, manic subjects give more "individual" reactions than depressed subjects; the reaction-time is equally slow for both groups. But here again, there are conflicting individual records.

III. RELATION BETWEEN CLINICAL AND EXPERIMENTAL RESULTS

1. Depressed Subjects

a. Pr. No retardation is shown in the tapping test, but there is a decrease in her tapping-rate at the time of her third trial (when depressed) over her first two trials (when normal). She is also much slower in the distraction and cancellation tests at this third trial than at the time of the other two. The rate of tapping, of cancelling, and of sorting cards is consequently decreased by her depression. All three of her association tests were normal in character.

b. Hi. Retardation shown in tapping-test in each series, but noticeable fatigue shown between series. No record in cancellation test due to poor eyesight. The slowest of all in the distraction test. Perfectly normal in association test. The tapping and distraction tests clearly show motor trouble, thus agreeing with the clinical description of being "rather slow, sometimes particularly with initial retardation."

c. Ha. No record in tapping. Extremely poor in weight test. Very slow in cancellation and distraction tests. In the latter about the same as Bu. but faster than Hi. Association-test—normal. The feeling of numbness and deadness in the body may be the cause of the poor showing in the weight test. She complained of it at the time of the test. Her slowness in the distraction test was apparently due to lack of motor control.

d. Bu. No retardation shown in individual series but an interserial warming-up suggested it. Extremely poor in weight test, possibly due to the feeling of deadness in head and body. Very slow in distraction test, next to Hi. in this respect. Cancellation slowest of all, but showing marked improvement in each test in speed and accuracy. Only subject tested who was noticeably poor in accuracy of cancellation. Association test—noticeable train of thought, only 19 "common" reactions. The tests all suggest lack of motor and mental control. But also a slow improvement in each test.

This improvement came too slowly, evidently, to show up in one tapping record, but did so when all series were compared.

The Group.—The clinical pictures of Ha. and of Bu. are very similar. The tests would indicate that the latter is much more deeply affected. Both would seem to come principally under the heading of depression with “associative retardation” or “thinking disorder.” Hi. would come principally under the heading of depression with “associative retardation” and Pr. under that of depression without formal alterations.

The tapping-test may indicate retardation by the opposite of fatigue within the series, and seems to indicate depression by lack of interserial warming-up, although this is present in Bu. The rate of tapping is also below that of normal subjects. The weight test is unsatisfactory, but extremely poor records are sometimes accompanied by loss of feeling in the body. Slowness in the cancellation and distraction tests is characteristic of depressives. The association-test shows no abnormalities except with Bu. Her record is characterized by responses from a train of thought connecting the reaction words.

2. Manic Subjects

e. Po. Rate of tapping decreased with the three tests, corresponding to her clinical condition of manic in the first, less so in the second, and normal in the third. Showed tendency to tap as fast at end of the series as at start in all three tests,—characteristic of retarded subjects (Wells). Interserial warming-up very prominent in first test, in second test in right hand, and high record in third test. The test shows, then, initial retardation but increasing excitement as the work continues. It is difficult to reconcile this tapping record with her clinical condition, unless the “difficulty in thinking” is an indication of some retardation—making her case one of the mixed states. Undoubted improvement in cancellation test accompanying improvement in attack. Improvement in distraction test also, but it is not so clear that this is due to the phases of the attack and not to mere practice. Association test—normal, all three records; a slight improvement in the tests in type of response and reaction-time but not more than what would be expected from practice.

f. Fr. No record in tapping, first time; second test normal. Time in cancellation and distraction tests equal to normal subjects. Twenty-two “individual” reactions in first of the two association-tests, 23 in second, also 5 “don’t

knows." The "don't knows" referred to words which she claimed she did not know although responding to them the first time. Time of the "common" reactions 18.3 fifths of a second first test and 15.3 the second; the "unclassified," 34.8 and 33.0, respectively. Only the association-test suggests she is not normal. Both of its records are abnormal, the second the poorer of the two. She was actually much more easily stirred up at the time of the second test. Whether or not there is any relationship between the two can not be answered.

g. Wa. Tapping-test, normal. Cancellation-test omitted due to poor eyesight. The latter factor accounts for the poor record in distraction-test. Twenty "individual" reactions in association-test, 11 "normal" and 8 "unclassified." Here again, only the association-test would indicate that she was abnormal.

h. Sh. Tapping-test, normal. Slowest of all, except Bu., in cancellation-test. Slowest of all in distraction-test. Here she did not co-operate but insisted on keeping the "kissing pictures" in her hands instead of sorting them. Association-test, 10 "individual" reactions, but 6 are "normal;" however, the reaction-time is extremely slow,—27.0" for the "common" reactions. Twenty-six of her 89 "common" were species-genus. Nothing in her clinical picture suggests the cause of these results except possibly the tendency to drift in her talk. At the time of the test she was "quite moderate," typically manic of a mild type.

i. Wi. Tapping-test, normal. Weight-test, poorest of all, no explanation as to the cause. Cancellation, a trifle slower than normal, distraction, much slower than normal, due to marked interest in the "kissing" pictures. Association-test, type of reaction, normal; but time rather slow (12.3"). "Male," "female," "human," and "useful" given whenever possible, with markedly long time for the first two. Tests do not do more than show up her marked interest in sex questions.

j. Re. Tapping test, manic excitability in that the tapping rate increases with the successive series. But she shows less fatigue within the series than normal subjects (especially with her right hand)—a characteristic of retardation. Weight test, poor. Number-checking test, normal. Distraction test, a trifle slow. Association test, 31 "individual" reactions, 10 of which are "normal," 26 "unclassified" and the remainder scattered among several sub-groups. The "unclassified" were incoherent, e. g., whiskey-Nova Scotia, religion-doughnuts,

eating-understanding, red-lamb, etc. Very fond of plural, e.g., deeps, ideas, seas, etc. Reaction time of "common" was 9.9, "individual" from 13.5 to 22.0. She was tested when the manic traits were quite marked. The tests indicate a manic condition except for the "reversal" within the series which is distinctly a retarded symptom.

The Group. The tapping test shows clearly an increasing rate of tapping as the work continued from series to series. But within the series there was no characteristic difference from normal subjects. It seems also quite certain that the gross rate of tapping is faster for these subjects when in the manic condition than it would be if they were normal. The weight test gave poor records with Wi. and Re.; no explanation is offered. Probably, manic cases are slower in cancellation and distraction tests than they would be if normal, some are noticeably slower. In the association test all but one had an abnormal number of "individual" reactions and long reaction times.

3. *Depression (suggesting Dementia Praecox)*

k. Go. Tapping test, showed a trifle more fatigue in the series than in normal subjects; no interserial warming-up. Number-checking tests, very slow. Distraction test, 20 seconds faster than any of the others, including the normal subjects, as fast as college men. This is the only noticeable case in which the number checking and distraction tests have not been reacted to in the same general way. Association test, 59 "individual" reactions, 13 of these being "normal," 38 "unclassified" and 6 "association to preceding reactions." The reaction time of the "common" reactions was slow (18.5) while to the "individual" reactions it was from 23.0 to 28.0. This subject is very troublesome to classify. Her tapping shows no interserial warming-up and noticeable fatigue within the series. In this she resembles dementia praecox subjects more than any other type. She is similar to the depressed subjects by being very slow in the number-checking test, but shows the opposite to that state in the distraction-test by being extremely fast. Her association record also suggests dementia praecox much more than manic-depressive insanity.